

Review and updating of the Moscovian to Artinskian marine rocks in peninsular Italy

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ABSTRACT

New and previous data on the mainly marine Carboniferous to Permian sequence of the Apennine Chain and its foreland in Italy (especially Tuscany plus Lucania and Apulia) are summarized. Of special interest is the restored correlation between a shallow-water carbonate platform and the related basin with turbidites and olistostromes, pointing to the Hercynian outer foredeep tectofacies.

MOTS CLÉS

Bashkiriën,
Vareyen,
Kashiriën,
Podolskien,
Bolorien,
Kubergandien,
fusulines,
conodontes,
coraux,
Toscane,
Lucanie,
Apulie,
Apennins.

RÉSUMÉ

Nous résumons ici les données, nouvelles et anciennes, qui concernent des dépôts, principalement marins, du Carbonifère au Permien des Apennins et de son avant-pays italien (particulièrement la Toscane, la Lucanie et l'Apulie). On notera tout spécialement l'établissement d'une corrélation entre des carbonates de plate-forme peu profonde et les turbidites et olistostromes liées au bassin adjacent, qui illustrent la tectonofaciès de l'avant-fosse hercynienne externe.

Moscovian and Artinskian units are emphasized here within the frame of Carboniferous to Permian sequence of rocks.

MOSCOVIAN (Fig. 1)

Fossiliferous marine sedimentary rocks datable to the Moscovian outcrop only in a narrow area of the northern Apennines, between Siena and Grosseto (Monticiano-Roccastrada area, Tuscany). Two main sequences have been separated (Cocozza *et al.* 1987): a northern one along the Farma river and a southern one in the San Antonio mine area.

The Farma river sequence, between Contrada Carpineta and 170 m a.s.l., near Iesa (43°5'N - 11°16'E) includes: (1) the Risanguigno formation containing Devonian silicified limestone (Bagnoli & Tongiorgi 1980); (2) a chert formation (lyditic radiolarites) of possible Dinantian age; (3) the Carpineta formation (Cocozza *et al.* 1974) of late Viséan to Moscovian age; and (4) the Farma formation (Cocozza *et al.* 1974) of late Bashkirian to late Moscovian age. This sequence, severely tectonized and largely overturned, is unconformably overlain by the Permian-Triassic Verrucano Group (Cocozza *et al.* 1974; Conti *et al.* 1991). Of major interest are the Carpineta and Farma formations.

The Carpineta formation, mainly shaly and silty with brachiopods, bivalves and plant debris, contains olistolithic intercalations of limestone rich in crinoids, algae and foraminifera. Brachiopods suggest a late Viséan to early Namurian age (Pasini & Winkler-Prins 1981) as well as the Archaeodiscidae found in the sandy-silty layers (Pasini 1980b). However, the foraminifera from the limestones suggest a late Bashkirian to early Moscovian age (Pasini 1978, 1980a).

The Farma formation is a thin bedded siliceous turbidite with few interposed limestone olistostromes and olistoliths. Limestones contained in the lower part of the formation and probably identical to the San Antonio limestone formation (see below) have been dated to the late

Bashkirian-late Moscovian (Podolskian to Mjackovian substages) by Ferrari *et al.* (1977) and Pasini (1978, 1980a). More precisely, Ferrari *et al.* (1977) reported two different foraminiferal faunas from the limestone olistostromes and from a loose dark limestone boulder: the first one, with *Profusulinella* and *Pseudostaffella*, was assigned to the zone 22 (or slightly younger) of Mamet, which is late Bashkirian to early Moscovian; the second one was tentatively assigned to the late Moscovian: Corals (*Spiriphyllum multilamellatum* de Groot) and conodonts (*Idiognathodus delicatus* Gunnell) yielded in the same boulder were assigned an early Moscovian and a late Moscovian age respectively.

Limestones from the upper part of the Formation show *Fusiella praetypica* Safonova of the Podolskian substage (late Moscovian). The Farma formation is more than 500 m thick (Conti *et al.* 1991).

The San Antonio mine sequence is located near Casal di Pari (Grosseto) (43°3'N - 11°17'E) and include: (1) the Carpineta formation (lacking olistolithic inclusions here); (2) the San Antonio limestone formation, 200 m thick, of late Bashkirian to early Moscovian age; (3) the paleosol horizon with bauxite; and (4) the Spirifer shales (Cocozza 1965) of late Moscovian (Mjackovian) to early Cantabrian age, which are exposed for 2 m only.

The San Antonio limestone formation is a dark to black, shallow-water, bioclastic limestone, partly dolomitized. It contains algae and foraminifera with fusulinids (*Ozawainella* ex gr. *O. grandis* Putrja) of early Moscovian (Vereyan to Kashirian) age.

The Spirifer shales contain *Pseudostaffella* cf. *sphaeroidea* (Ehr.) and brachiopods of latest Moscovian-earliest Cantabrian age (Pasini 1980a).

The Farma sequence is entirely basinal and shows a systematic deepening of the sedimentary environment. The San Antonio sequence suggests an almost steady outer shelf environment with a short emersion disconformity in the late Moscovian. Large parts of the two sequences are time overlapping. Both contain the

Pseudoendothyra-Pseudostaffella association which supports a close relationship also suggested by olistostromes and olistoliths supplied from the shelf to the basin.

ARTINSKIAN (Fig. 1)

Clear fossil evidence of marine Artinskian rocks in peninsular Italy was only found in the well PC/33b (42°50'50"N - 11°41'30"E) drilled by ENEL Co. on the Mt. Amiata (southern Tuscany). This well cored fossiliferous carbonate layers, containing fusulinids from - 3024.40 to - 3028.40 m beneath the surface. The core was made up of five elements, the deeper of which included *Præparafusulina* cf. *lutugini* (Schellw.)

and *Eopolydiexodina* sp.; therefore it was referred to the *P. lutugini* Zone of the Artinskian. Higher elements of the core, however, yielded fusulinids assigned to the genera *Cancellina*, *Yangkienia* and *Pseudodoliolina*, which have been referred to the Kubergandian.

The cored interval thus seems to represent a condensed Artinskian to Kubergandian sequence (Pandeli & Pasini 1990). The lack of fossils within the drilled deeper levels prevent an assessment of the total thickness of the Artinskian sediments.

The Palaeozoic sequence found in the well PC/33b is composed by the "A", "B" and "C" formations (Fig. 1), among which the "B" formation is viewed as a tectonic wedge of pre-Viséan age within the "A" formation. This

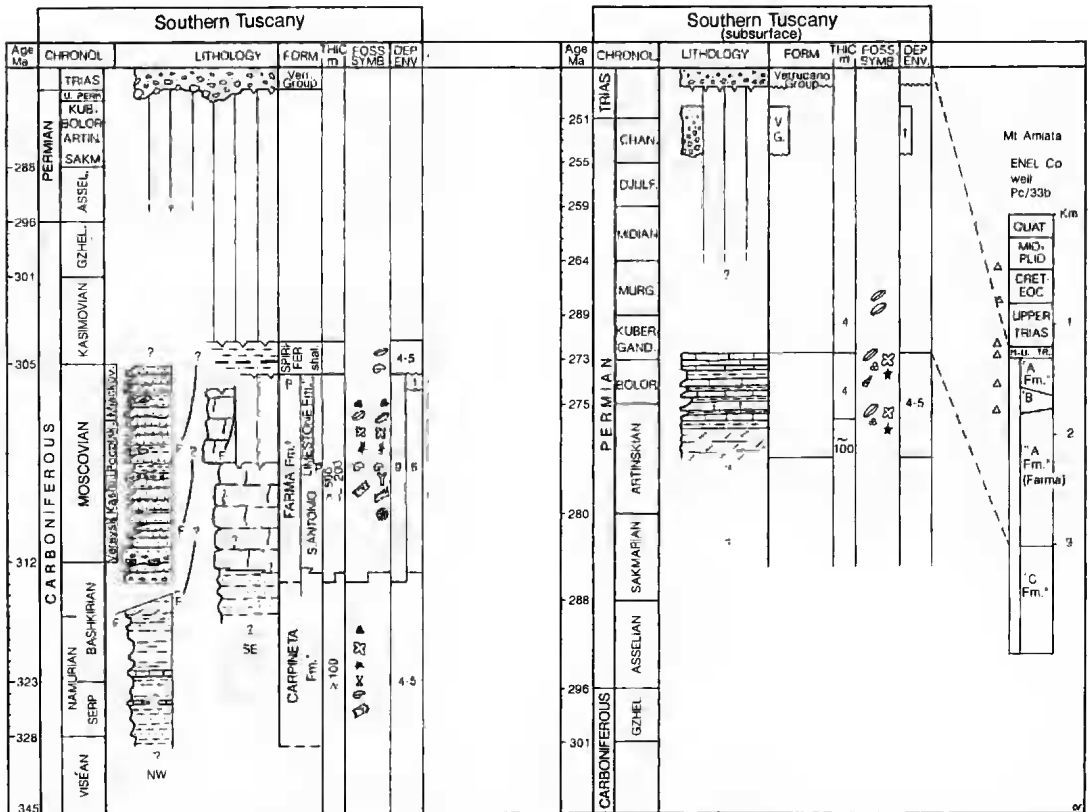


FIG. 1. — Mid to late Carboniferous, mainly Moscovian, stratigraphic sections in southern Tuscany and their interpretation (left); late early Permian stratigraphic section from the Southern Tuscany subsurface and their interpretation (right). See Vai & Venturini (this volume) for legend; F, fault.

sequence is unconformably overlain by the (?) Triassic Verrucano Group, and was interpreted as a reverse-recumbent fold or a complex pile of Alpine tectonic wedges (Conti *et al.* 1991).

RELICS OF THE MARINE PERMIAN

This is a review of subsurface, poorly exposed, or indirect evidences of Permian marine rocks in peninsular Italy.

Poorly exposed marine sediments of probable Artinskian age are represented by small carbonate lenses with rare fusulinids (*Parafusulina* of earlier type) (Bodechtel 1964; Kahler 1969), crinoids molluscs brachiopods and plant debris enclosed in the mostly marine Rio Marina formation of Westfalian/Stephanian to early Permian age, Elba Island (42°49'N - 10°26'E; Vai 1978).

Rare relics of uppermost Carboniferous to lowermost Permian with fusulinids and algae have been found as clasts within the middle Triassic Mt. Quioio Formation, Verrucano Group, southern Tuscany (43°6'N - 11°12'E; Engelbrecht *et al.* 1988).

Other relics are found in the middle Triassic Mt. Facito Formation, southern Apennines, near Potenza (40°28'N - 15°42'E; 40°12'N - 15°50'E; Donzelli & Crescenti 1970). Fusulinids and smaller foraminifera of late Permian (Murghabian to Dzhulfian age) are contained in resedimented conglomerates in the lower part of the formation (Panzanelli-Fratoni *et al.* 1987; Ciarapica *et al.* 1990). Rare Artinskian fusulinids (*Pamirina darvasica* Leven) are also found besides the late Permian microfauna (Pasini, unpublished data).

A possible source area for the Mt. Facito resedimented Permian conglomerates may be found in the poorly fossiliferous cuttings from the 4581-4698 m interval drilled by Conoco in the Gargano 1 well in 1984 (41°50'46"N - 15°24'30"E). It is composed of light grey limestone containing fusulinids of late Carboniferous to Permian age underlying a thick Jurassic and Triassic sequence.

Consistent with the above assumption is also the late Permian of the Apulia subsurface. A mainly continental alluvial plain sedimentation of late

Permian age (equivalent to the Southalpine Val Gardena Formation) containing some coastal lagoonal carbonate deposits in the latest Permian was drilled by Agip in the Puglia 1 well (41°3'30"N - 16°5'30"E).

The data discussed suggest a coherent picture of a mainly marine foredeep to foreland deposits punctuating the Carboniferous to Permian interval in the wide palinspastic space hidden in the present Italian peninsular area.

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